

Exemption No. 6420

**UNITED STATES OF AMERICA
DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
RENTON, WASHINGTON 98055-4056**

<p>In the matter of the petition of</p> <p>Learjet, Incorporated</p> <p>for an exemption from §§ 25.562(c)(5) and 25.785(a) of the Federal Aviation Regulations</p>	<p>Regulatory Docket No. 28269</p>
--	---

PARTIAL GRANT OF EXEMPTION

By letter L706-06-95-485 dated July 12, 1995, William W. Greer, Vice President, Engineering and Quality Assurance, Learjet Inc., One Learjet Way, P.O. Box 7707, Wichita, KS 67277-7707, petitioned for exemption from the Head Injury Criterion (HIC) of §§ 25.562(c)(5) and 25.785(a) of the Federal Aviation Regulations (FAR), for passenger seating in Learjet Model 45 airplanes.

Sections of the FAR affected:

Section 25.785(a) requires that each seat, berth, safety belt, harness, and adjacent part of the airplane at each station designated as occupiable during takeoff and landing must be designed so that a person making proper use of those facilities will not suffer serious injury in an emergency landing as a result of inertia forces specified in §§ 25.561 and 25.562.

Section 25.562(c)(5) requires that each occupant must be protected from serious head injury under the conditions prescribed in paragraph (b) of this section. Where head contact with seats or other structure can occur, protection must be provided so that the head impact does not exceed a Head Impact Criterion (HIC) of 1,000 units. The level of HIC is defined by the equation:

$$HIC = \left[(t_2 - t_1) \left[\frac{1}{(t_2 - t_1)} \int_{t_1}^{t_2} a(t) dt \right]^{2.5} \right]_{\max}$$

The petitioner's supportive information is as follows:

"Learjet's interest in this petition is to be able to offer aircraft to the public without the burden of added weight and expense based on Regulations which are still being 'fine tuned' and are being interpreted and applied differently among FAA Aircraft Certification Offices (ACO). The current Regulations are written such that there is no clear pass/fail criteria not subject to judgment.

"Historically, Regulations have dealt with technical matters by using predictable analytical techniques which can be controlled. Criteria dealing with human injury in a crash environment are based on human conditions and responses that can neither be easily predicted (too many variations in human physical characteristic, physical condition and environmental response/interaction) nor be controlled with any degree of repetition. Tests of this type can at best offer 'ballpark' results.

"Learjet Inc. seeks relief from the current Head Injury Criterion (HIC) of FAR 25.562(c)(5) for Learjet Model 45 forward, aft and side facing seats. All seats will meet all other requirements of the Rule and the crew seats will meet the HIC requirements; it is only the passenger seats for which the exemption is being requested."

"Recent industry activity concerning dynamic testing of aircraft seats has made it obvious that an industry wide concern exists as to the interpretation and administration of the Regulations and advisory material governing dynamic seat testing, that is, FAR 25.562, AC 25.562-1 and SAE AS8049. Recent industry meetings, such as the 28 February - 1 March 1995 Conference in Seattle, GAMA and AECMA meetings, and ARAC Seat Harmonization Working Group meetings have all addressed the problems which currently exist in certifying aircraft seating to the HIC requirements.

"All concerned parties have widely agreed that the original intent of FAR 25.562 was to increase the level of occupant safety and seat crashworthiness. However, through individual regional interpretation and widely published (and some not so widely published) advisory material, the straight forward test procedure and structural pass/fail criteria have been turned into a series of 'moving goal posts' requiring extensive, expensive test programs with no clear path to follow. Specifically:

- "1. Policy interpretation and guidelines are too confining and contrary to the original intent of the Rule. Clear definition of requirements has been replaced by post-test judgment calls and criteria changes.
- "2. The original NPRM analysis was incorrect and/or did not consider aircraft other than large transport aircraft (airliners). The calculated benefit-to-cost ratio of

2.6 in the NPRM is actually more like 0.01 to 0.025, based on actual seat test programs, as presented at the FAA Meeting in Seattle (Feb. 28 - Mar. 1).

- "3. The long accepted TSO process, as applied to TSO C127, is no longer valid. The aircraft seat is no longer 'model specific' like current 9G seats, but are now 'installation specific'. Seats fabricated by a seating manufacturer or an OEM with TSO certification cannot be legally installed in an aircraft without an additional long and expensive test program in order to certify the seat's particular installation; that is, location in the aircraft, relationship to other seats, and the cabin environment surrounding the seat. Since the seat manufacturers can only provide a fraction of the whole, then the TSO becomes useless.
- "4. The pass/fail criteria is not definitive. Resulting minor damage, such as small cracks, belt fraying, and detachment of equipment like tables, ashtrays, armrests, etc., is being cited as test failure when the original intent of having the seat occupant survive the crash with load path and restraint system still intact is being ignored. The deformed post-crash seat will not be used again. This minor damage is being used as pass/fail criteria even though the seat performed its intended function as specified in FAR 25.562.
- "5. Current Regulations specify the seat to be designed and tested using a 170 lb., 50th percentile Anthropomorphic Test Device (ATD). However, due to recent interpretation of FAR 25.785, HIC testing must now consider the 5th to 95th percentile ATD range during seat certification, while still using the 50th percentile ATD for actual tests. Realistically, this cannot be accomplished with any degree of accuracy. The 5th and 95th percentile head strike path cannot be correlated to the 50th percentile head strike path. The 5th and 95th percentile conditions would also react differently with regard to seat energy absorption and deformation. Furthermore, requiring consideration of the 5th and 95th percentile conditions, which are not directly called for in FAR's 25.562 or 25.785, would only increase already escalated seat certification program costs and schedules.
- "6. Analytical 'worst case' scenarios have not been accepted, but extensive and costly developmental programs are required to show which seat installations are possibilities for certification testing before the test plan will be approved. For executive jet aircraft, each seat in the aircraft is installed into a different environment, whether forward or aft facing and its orientation to sidewalls, cabinetry, etc. This, in some cases, can virtually double the test program schedule and cost.

- "7. Current rules and guideline material are designed for large airline type aircraft and do not take into account the unique and special configurations of smaller business and executive aircraft. An airliner manufacturer may only have 25 different seating configurations (both passenger and crew) in the production life of a particular aircraft model; while for the business jet market, each individual aircraft may have several varying seating environments which are different from any other aircraft for the same model and require additional testing.
- "8. As time goes by and experience is gained, interpretation of the certification Rules is changed by issued policy and guideline material. Seats certified today may not meet the rules as interpreted in six months or six months ago. This 'moving goal post' scenario creates confusion and frustration for the seat designers and manufacturers and adds to the total cost and test schedules of any program.

"COMMENTS IN THE PUBLIC INTEREST

"Owners of executive and business aircraft operate those aircraft in a far different manner than the carriers of the general public (i.e. commercial airliners). A business aircraft is not only a means of travel but an office in the sky and not a carrier of the general public. Which means, instead of row after row of seats, the executive floorplan is such that the passengers can communicate and work closely with one another in quiet comfort. Owners also strive to have unique aircraft reflecting their own unique tastes and flight profiles. This translates into interior floorplans with club groupings and side facing seats with fold-out tables and galley cabinets.

"The injury criteria as currently interpreted and administered prohibits the installation of certain floorplans and amenities, as well as drastically inhibits the flexibility to be unique and to make minor changes (as style and operational needs dictate) due to the high cost associated with certification. This truly has a detrimental impact on the executive/business jet market as we know it.

"Granting this exemption would allow that segment of the public, which wishes to do so, to retain the flexibility of choice they now have in the selection of interiors for business and executive aircraft at no significant increase in the purchase price or weight, without affecting the segment of the public which uses the common carriers.

"SAFETY ENHANCEMENT

"The affect on safety of the exemption of HIC can be viewed in terms of whether safety is increased by its adoption in the first place for this type of aircraft. The interiors of executive jet aircraft are inherently safer than airline type aircraft because they are used less, are better maintained, and contain furnishings and seating that are less injurious. Extensive use is made of

padded sidewalls and bulkheads, more seat cushioning, larger seat pitches, dual shoulder harnesses on side-facing seats, etc. These features have contributed to the excellent safety record for this type of aircraft with low passenger injury and fatality rates experienced in actual emergency landings prior to the implementation of the 16g dynamic seat rules.

"So the question is not if safety is enhanced by not meeting the HIC requirements, but if safety is really enhanced and the additional cost and schedule justified when it is met for this type of aircraft."

A summary of the petition was published in the Federal Register on August 23, 1995 (60 FR 43835). No comments were received.

The FAA's analysis/summary is as follows:

The FAA notes that much of the petitioner's justification relates to aspects of the rule other than the HIC requirement. For example, structural pass/fail criteria and damage to restraint systems. While the FAA acknowledges that there have been some uncertainties in these areas, they have, for the most part, been resolved and do not in any case relate to the subject of the petition. In this regard, concerns regarding whether the pass/fail criteria are definitive are not valid for the HIC, since it is quite specific and must be calculated in a prescribed manner.

The petitioner also questions the need to consider a range of occupants, and further questions the usefulness of doing so with the standard 170 lb. anthropomorphic test device (ATD). The range of occupant issue is characterized as a recent development. Certainly, the need to consider other occupant sizes has been evident since the issuance of Advisory Circular 25.562-1 in March of 1990 which states, in paragraph 3c, "The seat, restraint and related interior system should be designed for the range of occupants and environments for which it is expected to perform, not just for the dynamic test conditions described in this AC." The AC goes on to discuss, more specifically, head strike envelopes. There is, however, some question as to whether this provision was clear at the time, and there appears to be a difference in how it was applied on different programs. Within the last year, the FAA has proposed a simplified methodology for dealing with range of occupants concerns. This methodology did not introduce the requirement, however, but proposed a standardized means for addressing it.

With respect to the validity of using the standard ATD to address other sized occupants, the FAA agrees that this is not a perfect simulation. However, the intent is to provide a consistent level of injury protection for a range of occupants, and not just the occupants corresponding in size to the ATD. For this reason, it is considered acceptable to use the ATD specified in the regulation to address the range of occupants. The FAA notes that consideration of the 5th percentile female to 95th percentile occupants only increases the contact zone to be considered by approximately six inches on a vertical surface.

The petitioner states that analytical determinations of "worst case" have not been accepted, resulting in costly development programs. The FAA encourages the use of analytical methods to determine the "worst case" for test. These methods must be validated, however, and must have a basis in actual data. The FAA acknowledges that executive type seating can result in multiple potential head injury targets, which can complicate the test program. Nonetheless, the complexity of the interior is not in itself a justification for providing a reduced level of safety.

Other concerns cited by the petitioner, such as a change in the utility of the relevant Technical Standard Order and questions regarding the original benefit to cost ratio of the regulation, while not without merit, are not pertinent to the feasibility of compliance with the HIC requirement. With respect to evolving policy, there has been a great deal of experience gained both within industry and within the FAA regarding dynamic testing of seats. Consequently, this experience has been integrated into compliance methodologies and guidance within the scope of the regulations. For the most part, this increased experience has simplified compliance requirements.

The petitioner's principal arguments are that the business aircraft environment is different from commercial carriers and this difference is costly when complying with HIC. In addition, due to the historically good accident rate for business aircraft, the petitioner believes that the safety improvement brought about by compliance with the HIC requirement is not as great as for commercial aviation, or as predicted by the rule. The FAA agrees that business aircraft interiors are different than commercial transports and that these differences can result in a more extensive area for consideration of head impact. Conversely, the provisions cited by the petitioner, namely upper torso restraints and increased seat pitch, should serve to mitigate the complexity of the interior and simplify compliance. Other manufacturers of similar airplanes have, in fact, demonstrated compliance with the requirement. The FAA notes that HIC compliance for seats placed in repetitive rows should not be different for commercial or business aircraft.

While the petitioner has not made a distinction between HIC on seat backs and HIC on bulkheads (so called "front row HIC"), the FAA notes that compliance with the latter has been an industry problem. While there are several potential solutions, none appear to lend themselves to all applications. The installation of upper torso restraints could prevent head contact with sufficient spacing, although this is dependent on the specific arrangement. Other solutions, such as airbags, which are due to be introduced, are generally available at this time. The FAA has granted other exemptions for front row HIC until the end of 1996, and will do the same in this case. For the remaining seats, the exemption is not justified.

In consideration of the foregoing, I find that a partial grant of exemption is in the public interest, and will not significantly affect the overall level of safety provided by the regulations. Therefore, pursuant to the authority contained in 49 USC 40113 and 44701, delegated to me by the Administrator (14 CFR 11.53), Learjet Incorporated is hereby granted an exemption from the HIC requirements of

§§ 25.562(c)(5) and 25.785(a) of the FAR for front row passenger seats on Learjet Model 45 airplanes, subject to the following provision:

The petitioner shall submit a schedule for retrofit of the design solution (to any airplanes delivered that are not in compliance) by December 31, 1996.

Issued in Renton, Washington, on April 9, 1996.

/s/ Ronald T. Wojnar
Manager, Transport Airplane Directorate
Aircraft Certification Service, ANM-100